April 1, 2023

Dr. Mike Hegedus
Department of Engineering Science
Simon Fraser University
Burnaby, BC V5A 1S6

Re: ENSC 405W Final Project Proposal for KickPro

Dear Professor Hegedus,

Within the attached document, you will find the final project proposal for our product, the KickPro. The KickPro is a soccer training device that will pass the ball to, and analyze the patterns and placements of a shot made by a player. KickPro is designed as a retrofit tool that can be installed on any net that meets predefined criteria and will record collected data for review by the players and/or their coaches.

KickPro will consist of a physical ball-launching system, a player tracking system, and a feedback system that documents and evaluates the ball and player positions.

In order to present a complete and detailed overview of our product, the enclosed project proposal will highlight a clear scope, an analysis of the market capabilities and build costs, the plan used to design the device alongside its associated risks, and the individual experiences of the members of IronFoot Technologies.

The team at IronFoot Technologies is comprised of Jagpreet Grewal, who is in the computer discipline; Amirali Farzaneh, Tao Li, and Minh Phat (Henry) Tran, who are in the systems discipline; and Alon Singh and Zehui (Jeffrey) Lin, who are in the electronics discipline.

Thank you for considering our proposal. We look forward to hearing from you soon. Should you have any questions, comments or concerns, please reach out to our Chief Communications Officer, Jeffrey at zla167@sfu.ca.

Sincerely,

Alon Singh
Chief Executive Officer
IronFoot Technologies

ENSC 405W
PROJECT PROPOSAL
KICKPRO

A PROJECT PROPOSAL DOCUMENT BY IronFoot Technologies

WRITTEN BY

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IRONFOOT
Technologies

Executive Summary

IronFoot Technologies Inc is a disruptive company dedicated to revolutionizing the sports industry through innovative solutions. Our mission is to enhance sports training efficiency and improve player skills, ultimately empowering athletes to reach their full potential.

Our passionate team is committed to delivering cutting-edge products that meet the needs of our customers. With a focus on quality and innovation, we have developed KickPro, a state-of-the-art system that leverages artificial intelligence and automatic detection and tracking to provide real-time feedback to soccer players and coaches.

KickPro represents a significant opportunity in the sports industry, with a potential market that spans across multiple sports and regions. Our innovative technology has the potential to transform the way athletes train, enabling them to achieve better results in less time.

Based on our market expectations, we expect to achieve significant profits within the first year should we launch. With additional funding, we can fully bring KickPro to market and accelerate growth. Figure 1 below shows the clean aesthetic that will be advertised to our potential clients.

IronFoot technologies' team is composed of six exemplary engineering students, each committed to bringing this project to life.

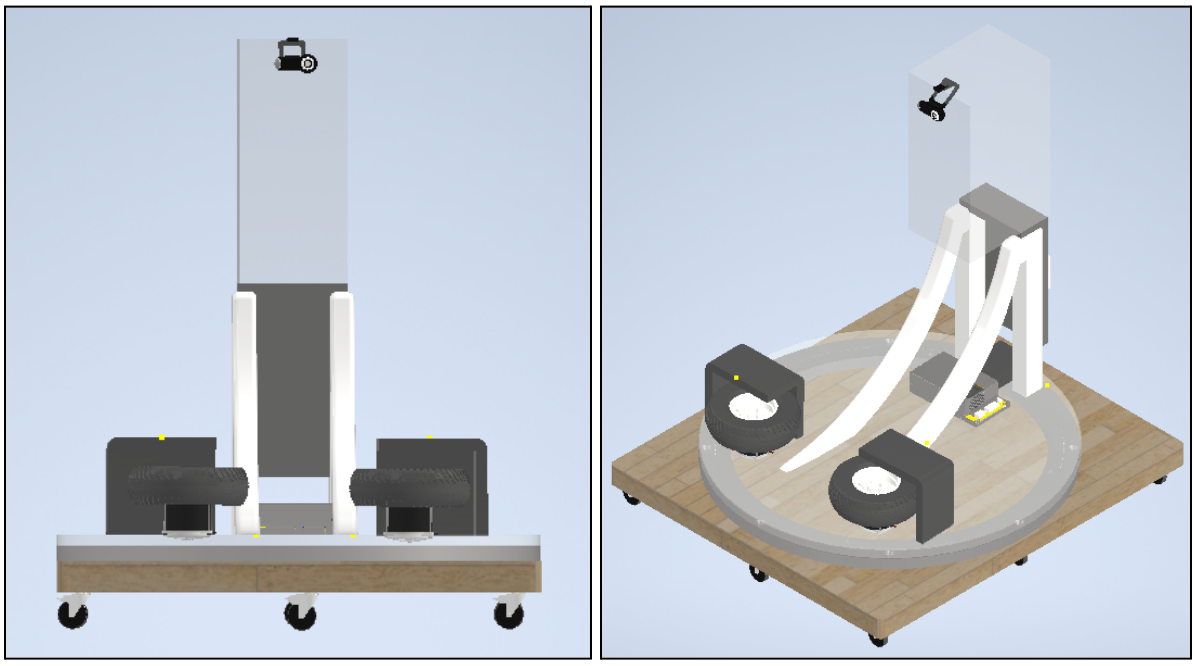

Figure 1: Overall Aesthetics and Structure of the KickPro prototype

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Glossary

Term	Definition
GUI	Graphic User Interface
MLS	Major League Soccer
NAIA	National Association of Intercollegiate Athletics
NCAA	National Collegiate Athletic Association
PCB	Printed Circuit Board

TABLE I: Definition of Glossary Terms

1 Introduction

The sport industry has been developing and fast-growing in several years, especially soccer which has attracted millions of people over the world; and the soccer industry economy has earned a lot of money from the brand name of soccer clubs originating from the Premier League or La Liga which have been sponsored from big clothing brands such as Nike, Adidas [1]. As a result of this, IronFoot Technologies Inc has come up with a technology to promote and improve the soccer training efficiency named KickPro with ambition to improve soccer skills for players as well as become one of the sponsors for soccer clubs in Europe.

In every soccer match and training nowadays, all soccer players are required to score as many as possible, which can lead their teams to winning. Scoring skills can be improved by practicing feedback data which are analyzed to give players instructions or recommend correct postures before aiming to score. For example, players can decide to modify body postures to score low shots or high shots into the goal [2]. Therefore, IronFoot Technologies Inc has introduced KickPro, a technology machine based artificial intelligence that is a highly competitive machine on the current market to reduce training time thanks to automatic detection and tracking technology in scoring and provide feedback to both trainers and trainees.

KickPro is supplied power by the plug-in sockets that is to bring up a whole electrical system and Raspberry Pi has an important role in controlling the system to navigate the launching direction correctly to player's position with state-of-the-art human detection technology, one of the modern computer vision. This is the main feature that provides users time, cost efficiency during training. Furthermore, the feedback is created by the ball's position in the net to evaluate the scoring skill thanks to our designed algorithm to track the ball. With this feature and the KickPro software application, the users will have more objective opinions about their scoring skill and quickly improve it.

Other views and aspects such as scope, risks, benefits, market and competition will be outlined and discussed in depth in this proposal. Also, the detailed schedule and stages for designing and developing KickPro are analyzed and listed carefully below.

2 Scope

KickPro consists of hardware and software systems that collaborate inside a pipeline to provide the desired outputs. The system starts with the push of a button that provides power to all of its components. When the system boots, the GUI is displayed on KickPros touchscreen. A start screen is initialized, where the user can begin their training session after a brief calibration. The user will be directed to the main dashboard of their training session, where they can alter launch settings and visualize the position of their scored goals on the net in real time.The KickPro will track and record key performance metrics and will output them in the form of a graph or prompts to the user through the "Performance Analysis" page of the GUI.

During a training session, KickPro will continuously track the user as they move around the field. When the user is ready, the product will communicate when the ball is going to be launched. The system will then calculate the distance between the user and itself, and will speed up its flywheel motors to launch the ball at the proper velocity. The player will then shoot the ball and if a goal is scored, the camera that continuously tracks the ball's position installed behind the net will determine the ball location in the net.

There is a microcontroller that's used in processing the human tracking software during calibration, the flywheel motor speeds, camera feeds, and all control circuits involved. A simple flowchart of the overall system is provided below in Figure 2 to help form a better understanding of the device's processing pipeline.

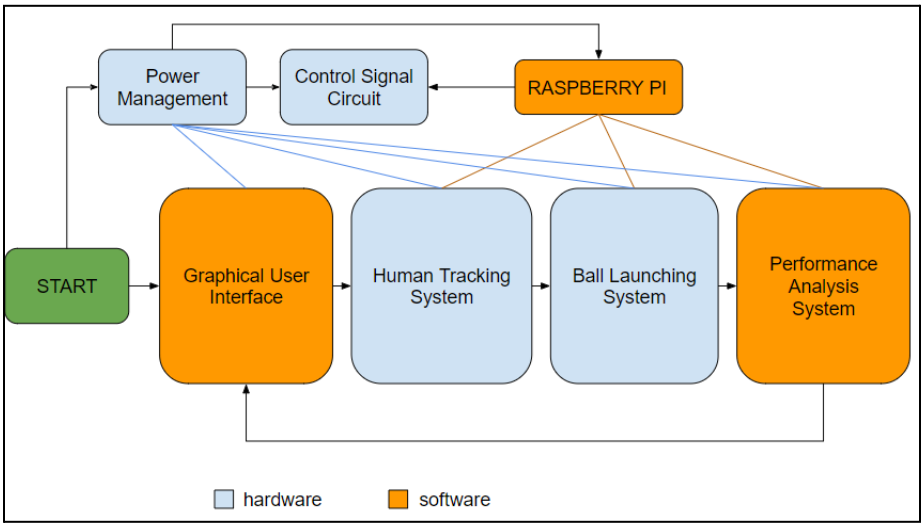


Figure 2: System overview of the KickPro

The two components that work together to make the KickPro are:

1. Human Tracking
    a. Software views the players on the field via a camera;
    b. Electronic signals are sent from the software to the servo telling it where to rotate to
    c. Mechanical servo, with its signal and power connection, rotates the entire assembly including the ball launching system to aim at the player.

2. Ball Launching
    a. Software tells the motors when to turn on at the beginning of the session;
    b. Electrical signals power and control the rotation of the motors, controlling the balls exit speed;
    c. Physical wheels attached to the motors grip the ball as it comes between them and passes it to the player.

3 Market Analysis

The soccer industry is one of the most lucrative industries in the world. With soccer being the number one most favored sport globally, estimating a fanbase of 3.5 billion viewers **[3]**, its popularity is translated into a high market value. In this section, we will discuss the methods to find the market value and competitors involved within industry.

3.1 Market Value

According to Deliotte, the soccer industry grew 10% in market size to $30.2 billion USD in 2020/2021, despite the COVID-19 pandemic's impact on the global economy **[4]**. However, our interest in market size lies within the current years, which is not available through public sources. Therefore, a variety of methods can be considered when determining market value of the industry in 2022/2023. For our purposes, we determine two major key factors such as club valuations and revenue streams.

For simplicity, we will analyze the European and North American men's leagues moving forward, as large market potential is identified within. We begin by finding the club valuations within the leagues, which includes the value of the players, stadiums, and branding of the team. Through KPMG's Football Benchmark datasets, we find that European teams are valued at a total of $42.014 billion USD in 2022 **[5]**. Additionally, we analyze the biggest North American league, MLS, and find its club valuation to be a total of $16.2 billion USD in 2023 **[6]**. With such values increasing with time, club valuations can be a great indicator of the industry's health and positive growth potential.

Revenue streams can be a great source of information for determining an industry's market size. Soccer clubs generate revenue through various sources such as broadcasting, matchday, and commercial. Broadcasting revenue, being the largest revenue source, streams from broadcasting rights given to the media. Matchday revenue includes tickets sales and merchandise sold during games. Commercial revenue stems from sponsorships, media commercial deals, and merchandise sales. According to Deloitte's Annual Football Money League report, the top 20 revenue generating clubs within the industry gained a total of $10 billion USD in 2021/2022, which was a 13% increase from the year before **[7]**. Although revenue streams are compared with years

impacted by COVID-19, this growth is an indicator of revenues surging to follow an increasing market size.

North American Market:

Associations	Number of Members
Canadian National Professional Club	11 [8]
MLS	26 (excluding Toronto FC, Vancouver Whitecaps FC and Club de Foot Montreal which are included in Canadian National Professional Clubs in the row above) [9]
Canada West Universities Athletic Association (U Sports)	17 [10]
Ontario University Athletics (U Sports)	20 [11]
Réseau du sport étudiant du Québec (U Sports)	8 [12]
Atlantic University Sport (U Sports)	11 [13]
NCAA Division I	205 [14]
NCAA Division II	206
NCAA Division III	415
NAIA	188
NCSA Junior	217

Table 3.1.1: Number of Notable Teams and Clubs in the North American Region

European League:

Associations	Number of Members
European Leagues	40 Member associations (note that each leagues consist of around 20 different professional clubs, hereby with an estimation of 800 teams) [15]
EUSA	47 Member national associations (note that each national associations consist of 50 to 200 university teams, hereby with an estimation of 4700 teams) [16]

Table 3.1.2: Estimated Number of professional clubs and teams in the European Region

As observed in the tables above, in the regions of North America and Europe alone, there are as many as a total of approximately 7000 professional/semi-professional teams and clubs that can be potential clients, where KickPro can help automate repetitive goal training. That being said, the continents of Africa and South America are also significant in the soccer business as well as the national teams of each country that are mentioned above. These reasons all indicate the longevity of the soccer business and the tremendous market potential a device like KickPro can have in the future.

3.2 Competitors

Through analysis of the soccer industry for products involving performance tracking, launching systems, and smart capabilities, we found that no similar devices are currently made. However, regardless of KickPros unique design and functionality, a variety of competitors may require to be outperformed.

Our biggest competitor is the "Ball Launcher." Their products involve two ball launching mechanisms shown in **Figure 3**, that are adjustable in speed or include an auto ball feeder which are similar in design to KickPro **[17]**. However, KickPro involves an automated tracking system that provides the user with accurate launches. Additionally, the product involves a performance tracking mechanism that will help enhance the users training experience.

Figure 3: Ball Launcher products

Another potential competitor is Catapult. Catapult produces wearable tracking devices that analyze a player's movements and use video analysis to provide performance feedback. Their products involve detailed key metrics that allow for information such as tactical decisions, athlete feedback, and talent identification **[18]**. Their product allows for detailed performance feedback which KickPro will be required to outperform. However, with KickPros multifunctional capability, the product will include a better automated training process.

Figure 4: Catapult One - a wearable device to detect player movements [18]

4 Cost Considerations

4.1 Cost Breakdown

The cost for each component of the KickPro project has been itemized in the following table:

Item	Cost	Qty	Amount
Package of Wheels	$38.69	1	$38.69
Motor	$37.99	2	$75.98
Servo	$39.99	1	$39.99
Power Supply	$112.98	1	$112.98

Motor Speed Controller	$27.20	1	$27.20
Converter Step-Down Module	$18.57	1	$18.57
Raspberry Pi	$419.99	1	$419.99
Lazy Susan (30in)	$50.00	1	$50.00
Metal wheel hubs	$1.69	2	$3.38
Solid Wood Board	$31.44	1	$31.44
Ring Connector	$1.30	1	$1.30
Fuse	$1.50	3	$4.50
Diode	$2.80	3	$8.40
Wheels	$10.84	2	$21.68
Wheels	$6.97	4	$27.88
6mm bolts	$0.48	17	$8.16
6mm flat washers	$0.13	17	$2.21
6mm nuts	$0.22	17	$3.74
Terminal Strip	$2.80	1	$2.80
Terminal Strip	$4.25	1	$4.25
Prototyping PCB	$3.80	2	$7.60
Sum Taxes			$105.37
Total			$1016.11

TABLE 4.1.1: KickPro Realized Costs

Our target proof-of-concept budget was $600. We have currently spent $1,072.27, putting us over-budget by $452.27. If essential components such as the Raspberry Pi were not facing a supply shortage, and thus a sharp increase in price, then we believe the disparity between our projected and realized costs would be greatly reduced. For now, all we can do is take away a lesson - the interconnected global economy affects all aspects of life, even university projects.

4.2 Funding

Due to the expensive nature of the project, IronFoot Technologies is aiming for financial support from these two resources:

1. Wighton Engineering Development Fund, administered by Dr. Andrew Rawicz
2. The Engineering Science Student Endowment Fund is provided by SFU's Engineering Science Student Society (ESSS) under Category B.

But should funding from these sources not be sufficient, our team is willing to pool together up to $180 from each member to cover expenses.

5 Project Planning

5.1 Gantt Chart

In this section, the overall project progress management starting after the project idea being finalized on February 1st has been laid out in detail. As displayed in the Gantt Chart down below, details about each section of the progress, such as the duration of tasks (in blocks of various colors), milestones (shown in gray diamonds) and sub items are shown.

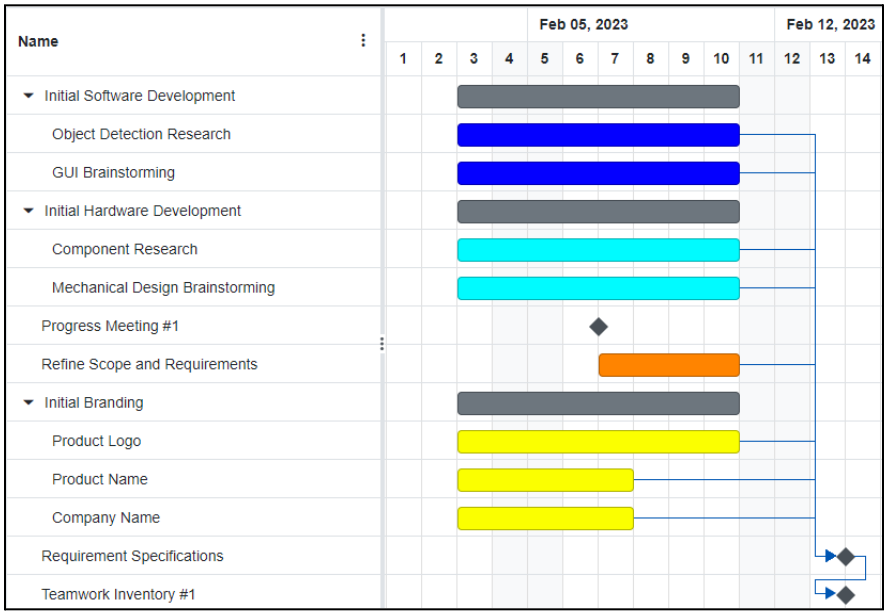


Figure 5: Progress before Feb 14

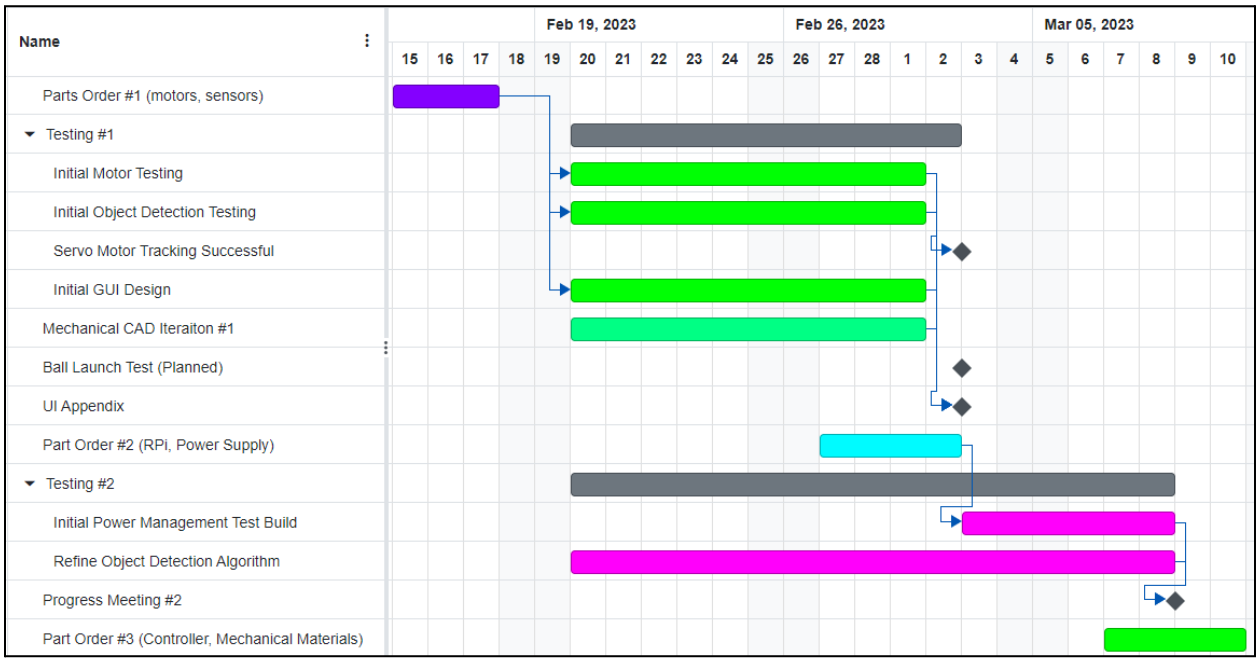


Figure 6: Progress from Feb 15 to the beginning of March

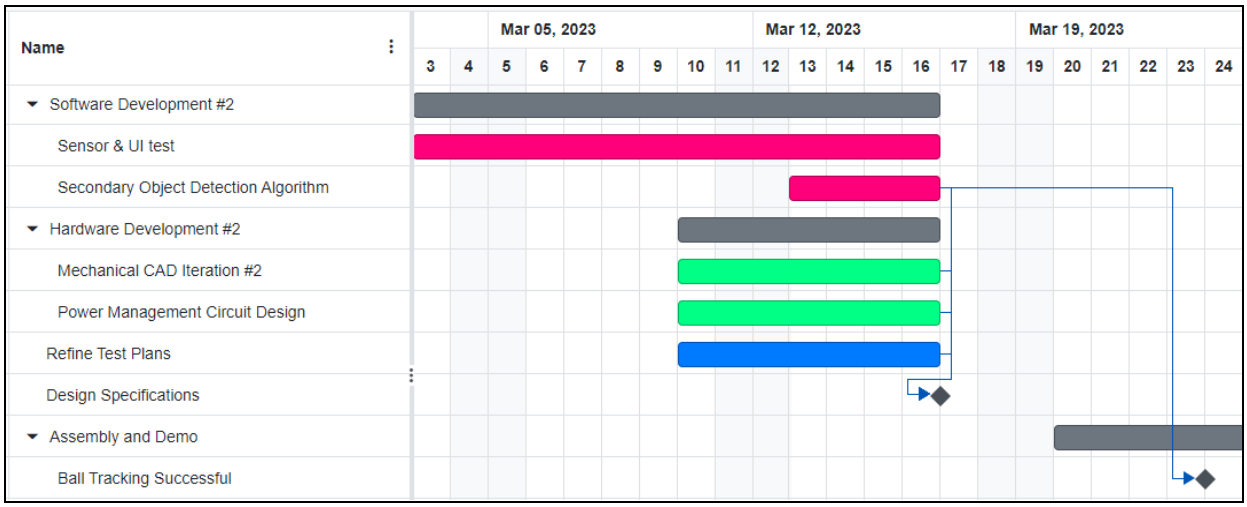


Figure 7: Progress of the remainder of March

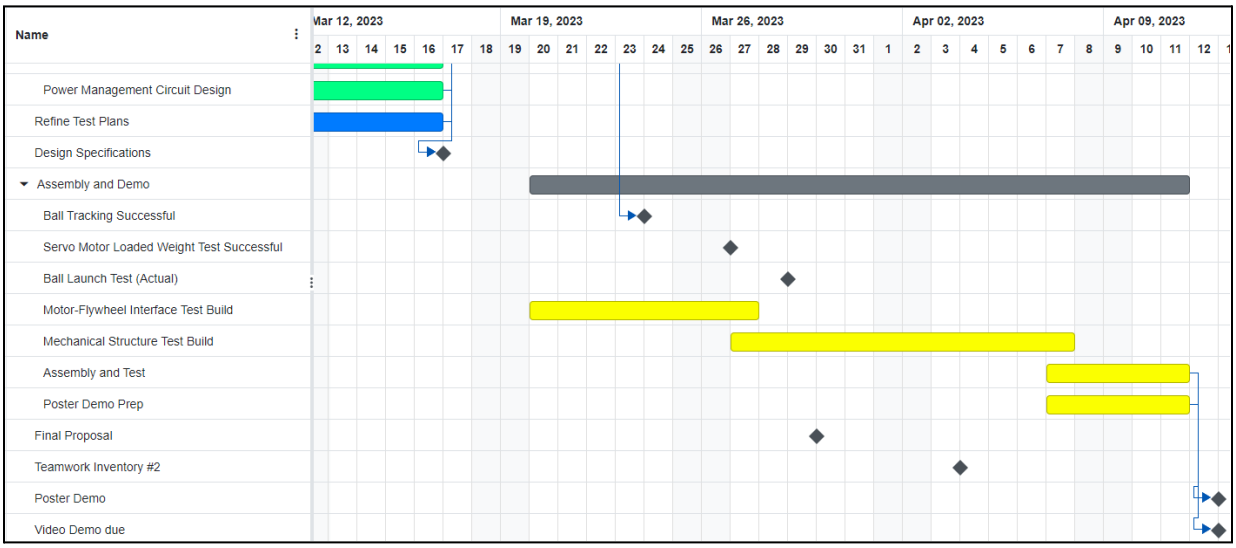


Figure 8: Final Progress before Proof-Of-Concept Presentation

As observed in the Gantt Chart segments above, most of the expected milestones are met with reality. The exception occurred when it was discovered that the brushed-motors-to-flywheel interface was not operating as ideally as expected, therefore delaying the Ball Launch Testing by more than three weeks, where our team went through multiple iterations of the design of the interface and finally came to a desirable outcome.

6 Risks/Benefits

6.1 Society risks

Safety risk: One of the societal risks associated with KickPro is the potential for personal injury. If the launcher is not properly designed, assembled, or used, it may cause injury to players or bystanders.

Noise pollution: Another potential social risk can be that the KickPro may continuously generate a lot of noise during its operation, causing disturbance to nearby residents.

6.2 Business risks

Profit: Developing and manufacturing KickPro requires substantial investment and resources, which poses a significant risk of not generating a return on investment

Competition: The KickPro may also face competition similar devices from other companies, which could potentially challenge the success of the product.

Credibility: if the product is not successful in the market, it may have a negative impact on IronFoot's reputation.

6.3 Benefit

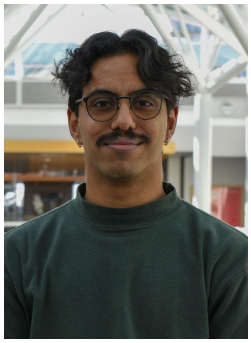
Societal benefits: Kicking a soccer ball is a much-loved traditional activity among youths and adults. A soccer ball launcher will only enhance this entertaining pastime. It can be particularly useful for soccer clubs for training programs and play performance analysis.

Business benefits: If KickPro succeeds, its entry into the market will garner significant revenues and profits for the company. Due to the huge market, soccer in Europe today generates billions of dollars in revenue.

7 Company Details

IronFoot technology was founded with the desire to help local professional soccer clubs to improve their players' performance at a relatively lower cost. Founded on February 5th, the first product, the KickPro, began immediate development to bring new technologies to the pitch.

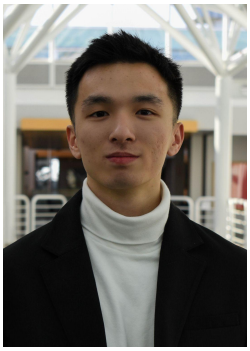
7.1 The Team Members



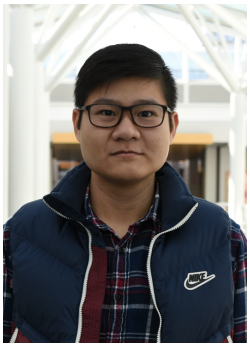
Alon is a 5th year electronics engineering student who brings experience in automation systems and mechanical design. He has interned as a mechanical engineer at Seaspan Shipyards where his main priority was bridging the gap between the mechanical and electrical teams, and as a test engineer at Labtest Certification Inc. where he designed test apparatus for several standards. Alon also enjoys photography and working on his car.

Amirali is in his 6th year of the Systems Engineering program at Simon Fraser University. Since his freshman years, he has developed a deep passion towards robotics and neural engineering/prosthetics. His studies allowed him to work within a variety of industries such as research with the Biomedical Optics Research Group, or industry as a test engineer at Shield-X Technologies. Through his mechanical expertise and marketing experience, he is fully committed to ensuring the success of IronFoot Technologies. In his free time, Amirali enjoys photography, hiking, and traveling.

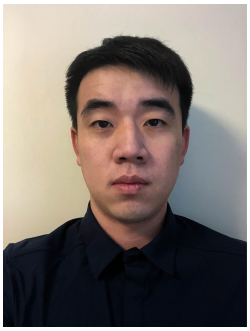
Jagpreet is a 6th year computer engineering student at SFU, with a keen interest in data science. Having previously worked as a Deployment Technician at Microserve for his internship, he has experience in IT and in setting up systems. Along with time as a volunteer for the Surrey Food Bank and Crime Prevention Society, Jagpreet has learned much about communicating with users and clients. In his free time, he enjoys traveling and recently joined the SFU Book Club and Tabletop Club. As part of the team, Jagpreet is responsible for integrating and developing software for the embedded subsystems, as well as managing finances.



Jeffrey is a 5th year electronics engineering student who is passionate in audio electronics design. Having interned at Radial Engineering and Lee's Electronics as well as currently working at Radial as a Hardware Validator, he provides electronics expertise to the team. Jeffrey has recently become involved in designing an RF antenna communication module for SFU Rocketry, and he also enjoys playing music in his free time. Jeffrey is also in charge of the team's external communications.



Minh is a 5th year systems engineering student with a minor in computing science who has interests in coding, programming backend software and designing firmware systems. With internship experience at Faculty of Applied Science as a Software Engineer and Microchip as Firmware Design Engineer, he has responsibilities for developing the software application and bringing up the firmware system for KickPro. He is also favored in traveling, soccer and music.



Tao is a 5th year systems engineering student with a keen interest in mechanical design, embedded systems, and real-time system processing. He has previously interned as a hardware engineer and FPGA test engineer at EVO-IN-Motion, where he gained valuable experience in system design and microarchitecture construction for FPGA boards. Also, Tao loves skiing and hiking during his free time.

8 Conclusion

Move Fast and Break Things. KickPro is an opportunity put forth by IronFoot Technologies to disrupt the sports industry. Using advanced technology, the team here has innovated and transformed how soccer coaching can be done - and serves as an example to move past the status quo in other athletic fields.

There is potential for growth. The sports industry, particularly soccer, has been rapidly growing over the years and attracting millions of fans globally. Top soccer clubs from leagues such as the Premier League and La Liga have generated significant revenue through sponsorships with major clothing brands like Nike and Adidas [1].

The system is easy to use for consumers - but no less complex. KickPro is powered by plug-in sockets, which activate the entire electrical system. Guided by a Raspberry Pi, using advanced human detection algorithms and custom-written source code, the ball-launcher diligently tracks the player's position. Another algorithm and subsystem record the shots on net and evaluate scoring ability.

IronFoot Technologies is passionate. Conceived as a capstone project, it should come as no surprise that this was a labor of love. Yet, it is no less ambitious. Facing no serious competition, the team believes this product has tremendous market viability.

Finally, IronFoot Technologies would like to extend its sincere gratitude to Dr. Mike Hegedus, Dr. Shervin Jannesar, Yalda Foroutanm, and Usman Ahmed for their support and encouragement. As well, IronFoot Technologies would like to acknowledge SFU Men's Soccer Head Coach Clint Schneider for his valuable expertise when designing this project. The team looks forward to working with everyone in the future.

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